CORE
Metadata, citation and similar papers at core.ac.uk
Provided by UNH Scholars' Repository

University of New Hampshire
University of New Hampshire Scholars' Repository

Honors Theses and Capstones

Student Scholarship

Spring 2020

Airline Fare Competition in the Post-Merger Era

Parker Michael Armstrong
University of New Hampshire, Durham

Follow this and additional works at: https://scholars.unh.edu/honors

Part of the Econometrics Commons, Economic Theory Commons, and the Other Economics Commons

Recommended Citation
Armstrong, Parker Michael, "Airline Fare Competition in the Post-Merger Era" (2020). *Honors Theses and Capstones*. 496.
https://scholars.unh.edu/honors/496

This Senior Honors Thesis is brought to you for free and open access by the Student Scholarship at University of New Hampshire Scholars' Repository. It has been accepted for inclusion in Honors Theses and Capstones by an authorized administrator of University of New Hampshire Scholars' Repository. For more information, please contact nicole.hentz@unh.edu.

Airline Fare Competition in the Post-Merger Era

Parker Armstrong

Adviser: Dr. Aziz Saglam

Abstract

This paper expands on the research of competition within the airline industry. This analysis estimates the fare-impact of new full-service or low-cost competition in city-pair markets in the domestic United States. Given the comprehensive restructuring of the airline industry as a result of the Delta-Northwest, United-Continental, and American-US Airways mergers, this analysis examines how the fare-impact of competition may have changed since the pre-merger era. This paper suggests evidence of a weaker effect regarding the entry of a low-cost carrier and a stronger effect regarding the entry of a legacy carrier in the post-merger era relative to the pre-merger period. The results support the hypothesis of convergence between the two business models.

Introduction

The airline industry is arguably one of the most competitive industries in the world. Third-party flight-searching websites aggregate data from almost every carrier, providing what economists refer to as 'perfect information' for consumers. The cost of flying is a relatively expensive bulk purchase for most consumers. As a result, airlines are incredibly price competitive to ensure that price-sensitive leisure customers choose their airline and not a competitor's.

Over the past fifteen years, the airline industry in the United States has dramatically changed. The Great Recession pummeled airlines' profits as consumers dropped travel and flight plans to save money. The significant financial struggles and bankruptcies in the industry prompted a series of mergers, with only three major legacy carriers remaining - American Airlines, Delta Air Lines, and United Airlines. These three airlines, all carriers with full-service business models, have been relatively profitable since their mergers. However, they are not alone in the skies. Low-cost carriers (LCCs) like Southwest, JetBlue, and Spirit, have grown in both route network and market share across the United States during the same time period.

As a result of the changing market structures, the effect of competition on fares may have changed as well. This research revisits the fare impact of low-cost competition in the post-recession, post-merger era. Unlike previous analyses, this study will investigate how what is commonly referred to as the 'Southwest Effect' has changed over time rather than during one period.

Literature Review

Low-cost carriers operate a significantly different business model compared to the full-service legacy carriers. In his book, *The Economics of Airlines*, Volodymyr Bilotkach (2017) outlines the general cost structures of the legacy and low-cost business models. It is important to examine the different business models in order understand how competition from LCCs has a different impact on fares compared to competition from full-service carriers.

First and foremost, low-cost carriers often have one type of plane model (allowing for different variations) across their fleet. For example, Southwest only operates Boeing 737s, but operates the 737-7 and the 737-8 models (the only major difference between the two being the length of the airplane). This streamlines maintenance and fleet management costs. Subsequently, it reduces pilot and crew training expenses.

Additionally, low-cost carriers tend to operate outside of the large, popular airports (Bilotkach, 2017). These airports tend to be slot controlled, and thus have incredibly high take-off and landing fees charged by the airport. This is why, for example, Ryanair (a major European low-cost carrier) does not operate out of London Heathrow, the largest of the six airports serving London. Rather, it operates out of London Stansted, a significantly less busy airport where its bargaining power over take-off and landing fee negotiations is much higher. Ryanair is a particular expert in this cost-savings method - often times they are the sole airline serving some airports. In fact, Ryanair not only gets to use some airport infrastructures for free, but has sometimes been able to negotiate payments from airports (Bilotkach, 2017). In this rare situation, Ryanair has been able to turn the cost-of-business to a revenue stream. Moreover, by using smaller, less congested airports, LCCs are able to manage quick turnaround times, as individual aircraft do not need to waste time in line for the runway, in a holding pattern waiting to land, or in the airport's taxiways waiting for the right-of-way in front of other airlines. This ensures maximum fleet utilization by allowing the planes to be in the air, making as many revenue-flights as possible in one day (Bilotkach, 2017). At some of these smaller airports, low-cost carriers do not necessarily use the expensive bridges that allow a seamless boarding and deplaning process, although this process is much less common in the United States than in Europe. For example, EasyJet often buses passengers from the airport to their tarmac-parked with a staircase offered for boarding.

Most famously, low-cost carriers have cut costs relating to passenger services. This includes in-flight meals, complimentary drinks, free checked-in and carry-on bags, in-flight entertainment, seats with reclining ability, extra legroom, and priority boarding. Low-cost carriers charge additional add-on fees for some of these services. These are important revenue-streams for LCCs and have turned into a method of price discrimination between passengers.

As an upside, passengers of low-cost carriers often do not need to deal with connections. This is because LCCs operate a point-to-point based route network, allowing passengers to simply board from city A and arrive at city B in one direct flight (Bilotkach, 2017). By operating outside of the hub-and-spoke model, where legacy carriers fly their passengers into a national or regional hub and reshuffle them to board a connecting flight to another destination, low-cost carriers find significant savings. First, low-cost carriers do not need to worry about connecting passenger's luggage (Bilotkach, 2017). More importantly, the lack of need to make checked-in luggage change planes significantly reduces the likelihood that luggage will be lost. Thus, low-cost carriers can save on costs regarding reconnecting lost luggage with frustrated passengers.

Through these methods, LCCs are able to drastically cut costs. In October 2015, the three large legacy carriers: American, Delta, and United, had costs per available seat mile (CASM) of 14.25, 14.96, and 14.87 cents respectively. Compare this to the low-cost carriers Southwest, JetBlue, and Frontier, whose CASMs were 11.16, 10.57, and 8.57 cents respectively. Most notably, Spirit Airlines was able to reduce its CASM to 7.64 cents, almost half of that of the legacy carriers (Bilokatch, 2017). Low-cost carriers have mastered cost-cutting tactics. These cost savings are often transferred to consumers through drastically lower fares compared to the full-service carriers.

Alves & Barbot (2009) argue that LCC's add-on revenue tactics to make their models profitable, even when they charge below-market fares. They note that LCCs charge for different levels of fares by imposing 'add-ons' for features such as carry-on and check-in bags, priority boarding, in-flight meals, non-middle seats, and extra leg room. This allows the airline to price discriminate against consumers and charge each costumer their willingness to pay for an extra-service. Furthermore, by implementing a Lo-Hi strategy (in which LCCs charge low prices very, very early before departure date and slowly increase the fare as the flight approaches), LCCs are able to further price discriminate against leisure passengers and business passengers. This enables them to profit off of the time-inflexibility of quickly booked business trips. In fact, with multiple consumers having varying probabilities of flying, this Hi-Low strategy is the dominant strategy for LCCs (Alves & Barbot, 2009).

Comparing the pre-recession era to the post-recession era, low-cost carriers have changed business practices and gained considerable success. According to the Bureau of Transportation Statistics (2016), the share of passengers carried by the larger network carries declined from 62.0 percent to 50.2 percent between 2003 and 2015. Atallah et. al (2018) finds that low-cost carriers have grown in terms of the share of markets they are competing in. Atallah discovers that between 2005 and 2015, the share of markets in which legacy carriers are the sole operators declined by approximately 10 percent. Subsequently, the share of markets with only LCC carriers provide service increased about 6 percent, whilst the share of markets where LCCs joined legacy carriers in service competition rose by 4 percent (Atallah 2018). They also note that pre-recession, LCCs were tended to enter new, previously unserved markets. By entering markets with fewer competitors, low-cost carriers gained monopoly power and were thus able to exploit their status as price makers, leveraging higher profits. However, post-recession, LCCs sought to challenge legacy carriers in markets where the major carriers had dominance.

Despite the challenging trends that legacy carriers face, Atallah (2018) notes that whilst LCCs are making inroads in terms of the share of markets they serve, they are not gaining flight shares in the markets in which they already compete. In terms of flight frequency (whether an airline operates one flight between the two cities per week, per day, or even multiple flights per day), LCCs have been losing market share. Atallah points to slot-controlled airports - as low-cost carriers begin serving new airports, the demand for those slots increase, thus driving up the price of valuable take-off and landing opportunities. Given their business model, low-cost carriers can only purchase one slot for the sake of competition, but increasing their frequency raises costs and potentially oversaturates the market, reducing load factors.

One of the most interesting subsections of airline literature examines how the business models of full-service and low-cost carriers are changing. Azadian & Vasigh (2019) argue that from 2000 to 2016, the business models of legacy carriers and low-cost carriers showed significant potential for 'converging.' They cite the fact that airline costs were seemingly steady between 2005 and 2008 during a period of rising fuel costs. The authors state that "the legacy airlines [moved] toward LCC business practices" during the period, referring to the series of mergers and cost-controlling measures encouraged by the Great Recession. Similarly, they argue that Southwest adopted practices resembling that of legacy airlines by increasing their connecting itineraries. If this were true, then the legacy airlines will have an easier time competing against low-cost carriers. In terms of the results of this analysis, business model convergence would be shown as a weaker effect of LCC entrance into a market in the post-recession era compared to the pre-recession era.

Ferrer-Rosella & Coender (2017) also find that the difference between the business models is closing. They suggest that in terms of expenditure allocation from travelers, the two business models are converging. They find that on average, passengers on legacy airlines were spending a closer share of expenses on transportation to low-cost carriers in 2014 compared to 2006. In other words, passengers traveling on low-cost airlines and full-service airlines spent the similar share of their budget on flight expenses in 2014. This implies that from a passenger cost perspective, low-cost airlines and legacy airlines are beginning to offer similarly priced fares. This can only be profitable (and therefore possible) through similar cost structures, indicating a convergence between the two business models.

The fare impact of low-cost carriers entering route markets has been thoroughly researched. Dresner et. al. (1996) analyzes the entry of low-cost carriers in markets between the first quarter of 1991 and the first quarter of 1994. He finds that the presence of any low-cost carrier reduces fares between 38 and 53 percent. However, he finds that the first low-cost carrier on average will reduce between fares by 4 percent and 8 percent, whilst the presence of two low-cost carriers will reduce fares between 26.9 and 30.5 percent. Additional analysis is completed for the presence of up to five or more low-cost carriers on the top 200 city-pair markets. Furthermore, the authors find that a low-cost carrier's presence is important even on 'competing routes', sometimes referred to as adjacent routes. An adjacent route is a route between two cities (for example, suppose Cincinnati and Washington DC), but by two different airports within one of the cities (CVG - DCA vs CVG - IAD). Analysis of adjacent routes is common, as consumers in multi-airport cities face airlines competing against each other, and even sometimes against themselves, with services within and between that city's airports.

Brueckner et. al. (2013) performed similar analyses for both nonstop and connecting service using DB1B data (Department of Transportation, Bureau of Transportation Statistics) between the third quarter of 2008 through the second quarter of 2009. Brueckner takes the interesting step of measuring the number of competitors with multiple variables - one variable representing when there are two or more legacy carriers offering nonstop routes, and another variable with three or more nonstop competitors, etc. This is a unique method of differentiating the effect of the entrance of the first competitor from a second competitor. This is in regard to the hypothesis that a second carrier entering a market will have a different effect than the third carrier entering the market (a hypothesis that fails to be rejected, according to the results of their models). Furthermore, their study focuses on the impact of Southwest and 'other' LCCs, in terms of both connecting and nonstop services entries. In their weighted market model, they find that the first legacy carrier with nonstop competition reduced fares by 4.3 percent, nonstop competition from Southwest suggests a 26.4 percent drop in fares, whilst other nonstop LCC competition reduces fares by 16.7 percent. Brueckner states that compared to the four quarters of 2000, competition from other legacy carriers has had a diminished effect. They believe this to be a result of three trends: (1) growth of LCCs venturing into new markets, (2) greater price information from third party airline search tools (i.e Orbitz, Kayak, Google Flights), and (3) changes in corporate buying patterns (more stringent corporate travel policies).

Kerry Tan (2016) also uses the DB1B database, but uses a much broader time period than Brueckner et. al. (2013), opting for the seventeen-year period from the first quarter of 1993 through the last quarter of 2009. Tan performs a time-series regression estimate for each 'incumbent' airline on a route. Legacy carrier incumbents reduced fares by an average of 14.7 percent in the quarter immediately following actual entry, relative to the fare of that carrier-market combo in the nine-to-twelve quarters before entry range. Notably, the author suggests that Southwest Airlines has the largest negative impact on fares when entering a market, following with the argument that other low-cost carriers may be 'enhancing' their effect on incumbent prices by dramatically expanding their route network and prominence in the airline industry. Overall, Tan concludes that what is commonly referred to as the 'Southwest Effect' is applicable to other low-cost carriers as well (namely, AirTran Airways, which merged into Southwest after Tan's publication, JetBlue Airways, and Spirit Airlines).

Kwoka et. al. (2016) analyzes the route-carrier-quarter level with DB1B Data from the third quarter of 2009 through the second quarter of 2010 (notably, the four quarters right after the Brueckner et. al. (2013) study). Kwoka et. al's analysis suggests a 13.8 percent drop in fares in competition from a legacy carrier, but nearly double the effect (26.8 percent) in reduction when there is competition from a low-cost carrier. Notably, compared to the Brueckner analysis, these effects are slightly marginal.

Theoretical Analysis

Competition between airlines is incredibly competitive. This is because the concept of 'perfect information' is fulfilled, as a result of websites like Orbitz, Kayak, and Google Flights that aggregate price information and ticket amenities that make it easy to compare products between airlines. Furthermore, the service offered by firms is nearly identical (quick transport from one city to another through the air), though there is room for some differentiation through add-ons and quality.

The effect of entry from a competitor can be described through simple supply-and-demand analysis. As another carrier enters the market, the incumbent carriers in monopoly markets lose their status as price-makers. The former-monopoly airline must then reduce its prices in order to attract consumers (this is proved through a simple game theory analysis). The entering airline does the same - offer low prices in order to gain market share and profit with full planes rather than empty ones. This property applies in all markets, regardless of how many incumbent carriers exist - as more airlines compete on the same route, each competitor will reduce prices in order to attract more consumers, thus increasing revenue and remaining profitable.

One area where carriers can differ in their service is through their route network. Consider the route market between LaGuardia (LGA) in New York City and PHX in Phoenix, Arizona. Airlines may offer nonstop service between the two, which is the most desirable product for consumers (as it is the quickest option). Subsequently, it may also be the most desirable option for carriers, as it reduces the costs of baggage transfers and potential lost luggage. However, some carriers may choose to compete on that route by offering connecting service. For example, United Airlines may fly passengers from LGA to their hub in Chicago at ORD, and then relay passengers to PHX. This allows United to offer fuller planes (increased load factors), as not all passengers on the LGA-ORD segment of the flight will end up in PHX, but may go to Seattle (SEA) or San Francisco (SFO). Offering connecting service allows airlines to earn more revenue, and thus may be able to offer lower prices whilst still maintaining profitability.

How does theory tell us how carriers offering nonstop service would react to competition from connecting service? It is difficult to say. Connecting carriers may be able to charge lower prices given their increased load factors. Thus, it would be obvious for the carrier offering nonstop service to reduce its fares in order to maintain market share and attract consumers. However, connecting service is often coupled with the hassle of long layovers, missed connections, and lost luggage - a lower quality service in the eyes of consumers. Therefore, nonstop carriers may not have such an incentive to reduce fares because they are offering a better product. Theory offers no definitive fare effect from competition from connecting service - the incumbent's reaction is ambiguous.

Another type of competition is adjacent competition from other airports that serve the same market. Continuing with the LGA-PHX example, suppose an airline begins nonstop service from JFK to PHX. Since LGA and JFK both serve New York City, nonstop competition from another airport serving the same market might be treated the same as if the latter carrier began service from LGA to PHX. For this reason, markets in this paper are not in terms of airport-pairs, but rather city-pairs.

In all of these, the magnitude of the effect may be dependent on the business model of both the incumbent and entering competitor. Low-cost carriers, as described earlier, undertake a significant array of cost-cutting tactics. These savings are passed along to consumers in the form of fares drastically lower than what some full-service carriers can offer. Therefore, when incumbents are full-service legacy carriers and face competition from entering low-cost carriers, they face significantly lower prices on the market. These low fares will attract rational consumers. As a result, legacy carriers will drastically reduce the airfares they offer in order to best compete against low-cost carriers. However, it is important to note that some consumers are not entirely price sensitive. In cutting costs, LCCs reduce flight service to the bare bones, often making it an uncomfortable and unenjoyable experience to fly. Low-cost carriers are only able to offer low fares by offering a lower-quality product. Theory may argue that the incumbent's reaction will be ambiguous. However, literature has often found that prices are the dominant factor in consumer's airline decision, thus giving low-cost carriers the edge in terms of competition. Thus, full-service carriers are forced to reduce fares significantly more when facing competition from low-cost carriers.

Economic theory may also be useful in hinting at how the fare effects of competition have changed given the change in the structure of the industry. Since there are fewer legacy airlines, it can be inferred that each are more likely to enjoy monopoly power on some routes (although the hub-and-spoke route network structure make connecting-service competition much easier and common). Therefore, the effect of the first competitor in the post-merger era may be larger compared to the pre-merger era given the possible increase in monopoly power.

The convergence of the business models of full-service and low-cost carriers may also bring some note-worthy theoretical insights. While this would not necessarily have a major impact on full-service to full-service competition (as both are able to match each other's lower prices with cost savings of their own), the magnitude of fare reduction caused by competition from low-cost carriers may not be as big as it once was. This is because low-cost carriers are taking on higher costs by offering service as larger, more expensive airports and offering connecting service. Furthermore, full-service carriers are actively engaging in techniques adopted by low-cost carriers. Therefore, full-service carriers can offer lower fares that are able to compete with low-cost carriers whilst remaining profitable. As a result, low-cost carriers are slowly beginning to look like full-service carriers, and the inverse is true as well. At full convergence, the business model of an airline would no longer play an effect on the magnitude of reaction from incumbent carriers. In other words, we would expect to see the effect of competition from the first legacy and low-cost carrier to be closer in the post-merger era as a result of the converging business models.

Data and Methodology

Data Sample

This study uses data from the US Department of Transportation's Passenger Origin-Destination Survey, otherwise known as the DB1B database. It is a 10 percent sample of all US-domestic flight itineraries sold from reporting carriers (all major American airlines and their regional affiliates are included within this). DB1B data is public and released quarterly. Given that the first major merger between Northwest and Delta commenced in 2008 and the most recent major merger between US Airways and America Airlines finished October 2015, this study examines flights in two three-year periods: from the first quarter of 2005 to the last quarter of 2007, and the first quarter of 2016 through the last quarter of 2018.

Of this comprehensive data sample, a smaller subsample was used for modelling. First and foremost, only economy-cabin, roundtrip itineraries were included for the study (after other filters mentioned below, 98.15 percent of all itinerary tickets within the sample were roundtrip). This contrasts the Brueckner study, where one-ways were included and roundtrip fares were divided in half to represent the fare of a one-way segment. This paper does not include that process. Airlines offer special discounts to roundtrip fares that cannot be obtained with the aggregation of two one-way fares. For the same reason, multi-city fares were also dropped, as they are simply the collection of multiple one-way fares with no discount. Additionally, all 'open-jaw' itineraries where a roundtrip passenger does not return to their city-of-origin are dropped. Thus, the remaining subsample is the set of roundtrip itineraries that were in a simple outbound-and-return form. It should be noted that any flight segment with layovers is not necessarily excluded from this subsample as long as the origin and destination cities are reached in a continuous stretch of flights.

Nonstop and connecting itineraries are included. For an itinerary to count as nonstop, both the outbound and the return tickets must have only one coupon, indicating there is one flight and thus no layovers between the origin and destination cities. Any flight that has two or more coupons (indicating at least one layover) on either it's outbound, return, or both of its flights will be marked as a connecting itinerary.

Itineraries with multiple ticketing carriers are also dropped (for example, an itinerary where the passenger purchases a ticket with Delta on the outbound leg and United on the return leg is dropped). This is because it is likely that the trip was sold as two one-way fares from each airline though a third-party seller (Orbitz, Expedia, etc.). However, this does not necessarily mean that itineraries with multiple *operating* carriers are dropped. To mark the difference: the ticketing carrier is the airline that sells the ticket to the passenger, but is not necessarily the airline that operates that flight. The operating carrier is the airline whose plane and resources are used to transport passengers. It is common for an itinerary to have one ticketing carrier, but multiple or different operating carriers through codeshares, joint ventures, interline agreements, or regional affiliations. For example, American Airlines may operate one segment through their own brand, but then another segment with Republic Airways (an operator of the American Eagle brand). Any itineraries that include multiple ticketing carriers are dropped as explained above, but this does not mean that itineraries with multiple operating carriers are dropped as well.

It should be noted that any regional affiliates were 'grouped' into their mainline carrier, i.e. any operator that works with United Airlines to serve under the United Express brand such as SkyWest, GoJet, and ExpressJet was renamed in the data to be United as long as the ticketing carrier was also United.

In terms of outlier fares, all fares less than $25 were dropped, similar to a step taken by Brueckner et. al. (2013) and Tan (2016). Additionally, fares five times larger than the median fare for that route on that quarter. Bulk fares were dropped, given their generally higher fares. Finally, the DB1B database provides an indicator whether the dollar fare amount is credible. Any remaining itineraries with in-credible fare values were excluded.

To help isolate causality and induce a 'base' fare for comparison, all routes included in the sample must have had at least one legacy carrier flying in at least one quarter throughout the time period. It should be noted that 97.15 percent of all tickets in the final subsample were on routes that had legacy carrier service on all twenty-four quarters of the two time periods.

Population and income data are retrieved from the Bureau of Economic Analysis and the US Census Bureau.

Methodology

The model in this paper is built in consideration with previous models, mainly Brueckner, Lee and Singer's (2013).

Airlines counted as full-service carriers include: American Airlines (AA), Delta Airlines (DL), United Airlines (UA), Alaska Airlines (AS), Hawaiian Airlines (HA), Northwest Airlines (NW), US Airways (US), and Continental Airlines (CO). Airlines considered to be low-cost carriers include Southwest Airlines (WN), JetBlue Airways (B6), Spirit Airlines (NK), Allegiant Airlines (G4), Frontier Airlines (F9), Sun Country Airlines (SY), Virgin America (VX), and Air Tran Airlines (FL).

As stated in the theoretical analysis section, cities, rather than airports, serve as the basis for determining markets in this model. This means that any flight from JFK to DEN would be considered in the same market as EWR to DEN, as the DB1B Database 'city market id' variable classifies that both JFK and EWR serve the same city/metropolitan area.

Furthermore, the directionality of the round-trip studies is disregarded. For example, an itinerary from New York to Seattle would be counted under the same "city-pair" market as an itinerary from Seattle to New York.

Each observation in the DB1B database was aggregated and averaged, using passenger-weights, to the market-quarter level. This means that the fare of each observation in the final dataset is the weighted average of all nonstop and connecting fares between two cities in either direction.

Given the panel data, a fixed-effects regression was used. The 'individual' for the regression was the city-pair. The use of a fixed-effects regression allowed the model to capture time- and market-invariant effects of each route.

Four variables were used to build the 'base' fare. Ideally, the resulting fare from these four variables would create the fare in the monopoly market. In the model, these variables are the *population, income, passengers,* and *distance* variables. The *population* variable is the geometric mean of the populations of both endpoints on the route. Similarly, the *income* variable is the geometric mean of the per-capita incomes of the cities on both sides of the route. The *distance* variable is the minimum distance flown between two cities on any of the tickets. This is the closest way of determining the actual distance between two cities without needing another data set. It should be noted that although this was calculated as the minimum distance flown between two cities, it is the same for both nonstop and connecting flights. Finally, the *passengers* variable is generated as the number of passengers that flew on the route during that quarter. This variable is the only one of the four that is expected to be negative - more passengers flying on the route means fuller planes, thus allowing carriers to reduce fares.

The competition variables are set up to determine incremental effect of additional competition relative to one legacy carrier. In other words, the model assumes that all markets are set up originally with one legacy carrier operating nonstop service between the two cities. There is a unique competition variable for each business model's nonstop service that determines the incremental effect of its entry into the market. For example, consider *legacy_nonstop3*. This coefficient on this dummy variable will demonstrate the effect of a third full-service carrier entering the route. This is because the effect of the first carrier's entry is shown by setting up the fare through the *income, population, distance,* and *passenger* variables. The effect of the second carrier's entry is already shown by the *legacy_nonstop2* variable. Thus, the incremental effect of the third full-service carrier entering the market is described by *legacy_nonstop3*.

In the construction of the connecting variables, the same rule applied: equals one if a carrier is offering connecting service on a route and equals zero if a carrier is not offering connecting service on that market during a quarter. However, since connecting service is a ‘lesser quality’ product compared to nonstop service, any carrier offering nonstop and connecting service on a route is only counted once as providing a nonstop service. Thus, if three carriers offer nonstop service on a market, one of which offers connecting service, whilst two other carriers offer connecting service and not nonstop service, the model sees three nonstop carriers and two connecting carriers. This is a similar step taken in the Brueckner et. al. (2013) study.

There are a few assumptions that should be noted. First, there are multiple dummy variables showing the incremental effect rather than one continuous variable with the number of carriers because the impact of a third carrier assumed to not be equal to that of a second carrier’s entry. Secondly, since there are less than 1,000 route-quarter observations where a *legacy_nonstop4* variable would equal one on a dataset of more than 275,000 route-quarter observations, the effect of any carrier after the third is assumed to be the same as the third carrier’s entry. Thus, each competition variable stops after the third nonstop competition variable.

Regression Model

The general equation for the fixed effects regression is as follows:

$$\begin{gathered} Ln(Fare) = \beta_0 + \beta_1(Income) + \beta_2(Population) + \beta_3(Distance) + \beta_4(Passengers) \\ + \beta_{5,6,7}(Legacy\ Competitiors) + \beta_{8,9,10,11}(LCC\ Competitors) + \beta_{12}(Post) \\ + \beta_{13,14,15}(Post * Legacy\ Competitiors) + \beta_{16,17,18,19}(Post * LCC\ Competitors) \\ + \alpha_i + \delta_j + \varepsilon_{i,j} \end{gathered}$$

*The overall model is weighted by the total number of passengers traveled on the route during the two time periods - busier routes are thus weighted more strongly and have higher influence on determining the coefficients.

Data Diagnostics

The diagnostics in *Table 2* below represent the means and standard deviations of each of the variables from the final data set filtered as described in the methodology section.

One of the most interesting results of the diagnostics came from a variable excluded for comparison: *legacy_nonstop1*, a dummy variable that equals one when there is any legacy carrier offering nonstop service on that route. Although the variable is not included in *Table 2* since it is not in the regression, it is worth noting because of interest. According to the data, 88.82 percent of all route-quarters did not have at least one legacy carrier offering nonstop service (the route-quarter *could* have had connecting legacy carrier service). However, when weighting each route-quarter by passengers, approximately 78.63 percent of all passengers flew on route-quarter combinations where a legacy carrier did offer nonstop service. This shows the importance of weighting the data by passengers carried on each route.

Table 1: Variable Descriptions

Variable	Description
Ln(Fare)	The natural log of the passenger-weighted average fare of each market
Income (1000s)	The geometric mean of the yearly per capita incomes of the connected cities
Population (100,000s)	The geometric mean of the yearly populations of the connected cities
Distance (100s)	The minimum distance ever flown between two cities (roughly similar to the geographic distance between two cities)
Passengers (100s)	The sum of all passengers flying nonstop or connecting service between the two cities
Legacy_nonstop2	Dummy variable, equals 0 if there is only one nonstop legacy carrier on the route, equals 1 if there are two or more legacy carriers offering nonstop service.
Legacy_nonstop3	Dummy variable, equals 0 if there is are two or less nonstop legacy carrier on the route, equals 1 if there are three or more legacy carriers offering nonstop service.
Legacy_connect1	Dummy variable, equals 0 if there are no connecting legacy carriers on the route, equals 1 if there is at least one legacy carriers offering connecting service.
LCC_nonstop1	Dummy variable, equals 0 if there are no nonstop low-cost carriers on the route, equals 1 if there is one or more legacy carriers offering nonstop service.
LCC_nonstop2	Dummy variable, equals 0 if there are no nonstop low-cost carriers on the route, equals 1 if there are two or more legacy carriers offering nonstop service.
LCC_nonstop3	Dummy variable, equals 0 if there are no nonstop low-cost carriers on the route, equals 1 if there are three or more legacy carriers offering nonstop service.
LCC_connect1	Dummy variable, equals 0 if there are no connecting low-cost carriers on the route, equals 1 if there is one or more legacy carriers offering nonstop service.
Post	Dummy variable, equals 0 if the observation is in the pre-merger era (2005 - 2007), equals 1 if the observation is in the post-merger era (2016 - 2018)

Table 2: Data Diagnostics

Variable	Unweighted, Route-Quarter Level n = 275,281		Weighted by Passengers in each Quarter n = 98,103,962	
	Mean	Std. Dev.	Mean	Std. Dev
Ln(Fare)	5.887	0.383	5.520	0.409
Income (1000s)	41.716	8.520	49.432	10.490
Population (100,000s)	9.619	9.487	41.389	29.169
Distance (100s)	18.160	11.615	12.268	7.457
Passengers (100s)	3.564	18.221	96.729	129.989
Legacy_nonstop2	0.034	0.181	0.522	0.500
Legacy_nonstop3	0.009	0.096	0.277	0.448
Legacy_connect1	0.965	0.183	0.859	0.348
LCC_nonstop1	0.080	0.272	0.750	0.433
LCC_nonstop2	0.019	0.136	0.389	0.488
LCC_nonstop3	0.005	0.068	0.166	0.372
LCC_connect1	0.153	0.360	0.468	0.499
Post	0.448	0.497	0.498	0.500
*Post*Legacy_nonstop2*	0.172	0.130	0.262	0.440
*Post*Legacy_nonstop3*	0.009	0.096	0.131	0.337
*Post*Legacy_connect1*	0.437	0.496	0.390	0.488
*Post*LCC_nonstop1*	0.046	0.210	0.396	0.489
*Post*LCC_nonstop1*	0.015	0.120	0.261	0.439
*Post*LCC_nonstop3*	0.004	0.062	0.118	0.322
*Post*LCC_connect1*	0.074	0.262	0.215	0.411

Results

Table 3: Fixed-Effects Regression Estimates

Variable	Coefficient	Standard Error
Income (1000s)	0.0022085***	1.03e-06
Population (100,000s)	- 0.0018858***	1.73e-06
Distance (100s)	0.0015392***	1.99e-06
Passengers (100s)	- 0.0014013***	1.66e-07
Legacy_nonstop2	- 0.003251***	0.0000139
Legacy_nonstop3	- 0.0359914***	0.0000139
Legacy_connect1	0.0111292***	0.0000248
LCC_nonstop1	- 0.1462011***	0.0000145
LCC_nonstop2	- 0.0399968***	0.0000148
LCC_nonstop3	- 0.0110259***	0.0000211
LCC_connect1	- 0.0306448***	0.0000109
Post	- 0.4485369***	0.000317
*Post*Legacy_nonstop2*	- 0.0334525***	0.0000164
*Post*Legacy_nonstop3*	- 0.029655***	0.0000229
*Post*Legacy_connect1*	- 0.0571541***	0.0000273
*Post*LCC_nonstop1*	0.0145194***	0.000017
*Post*LCC_nonstop1*	- 0.0918607***	0.0000185
*Post*LCC_nonstop3*	- 0.0466627***	0.0000239
*Post*LCC_connect1*	0.0229644***	0.0000129
Intercept	6.034493***	0.0000846

Statistical Significance Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Discussion

From the regression, we see have multiple inferences from the data. Notably, all coefficient estimations have a p-value less than 0.01. This means that there is a 0.1 percent change of a Type I Error, giving us 99.9 percent confidence in the estimation of our coefficients. It should be noted that this first model assumes no heteroskedasticity, but a regression with robust standard error is performed later, resulting in some coefficient estimations losing their statistical significance.

First, we shall discuss the four regressors that are constant across the pre-merger and post-merger era.

The coefficient of the *income* variable is 0.0022, suggesting that for every additional one thousand dollars (since the data is in terms of thousands of dollars) of the geometric mean of per capita income between the two cities, the airfare on that city-pair market will increase by 0.22 percent. This is perhaps backed by economic theory, specifically the law of demand. As incomes rise, consumers will make more purchases, with airline tickets being amongst those purchases. Demand for air travel increases, thus increasing the fare.

The coefficient of the *population* variable is -0.00189, which infers that for every one-hundred thousand person increase in the geometric mean of the populations between the two cities, average airfare will decrease by 0.12 percent. Economically speaking, this is difficult to back up by theory. However, it may make sense in the following mechanism: larger populations may boost demand to the point where flight frequencies increase. This creates competition within a carrier to fill more planes, and thus requires the airline to decrease fares to incentivize more travelers to buy tickets.

The coefficient on *distance* is 0.00154. This suggests that for every additional one hundred miles between cities, airfare increases on average by 0.15 percent. This makes sense: farther distances increase fuel costs for airlines, who must then raise prices to compensate.

The coefficient for *passengers* is approximately -0.0014. This implies that for every additional one thousand passengers flying on that route market, the average airfare decreases by 0.14 percent. This defies economic theory, which states that the more consumers there are in a market, the more prices there are. However, this may be correlated with the number of carriers serving a market, and thus may be ‘absorbing’ some of the effect of competition, as more passengers often requires more carriers.

The competition variables will be discussed broadly, rather than individually. In the pre-merger era, nonstop competition from legacy carriers had a small reduction on incumbent fares. Whilst nonstop competition is negative, it is surprising that competition from a legacy carrier offering connecting competition has a positive coefficient - suggesting that connecting competition increases incumbents’ fares. This is perhaps because connecting service is ‘worse’ compared to nonstop service. Therefore, carriers offering nonstop service can ‘raise’ fares, as the alternative to their travel product is superior to any competitor.

In the post-merger era, we can imply from the negativity of the interaction terms that the reduction of incumbent fares in the pre-merger era is enhanced in the post-merger era. This is true for both nonstop and connecting competition. The enhanced effect suggests that competition from legacy carriers is more intense in the post-merger era relative to the pre-merger era.

Theoretically, this may be the result of a multitude of mechanisms. The first is the expansion of third-party fare aggregation companies, like Orbitz, Kayak, and Google Flights. Websites like these allow consumers to compare flight prices more easily, thus increasing the incentive for airlines to reduce prices relative to their competitors. Additionally, this may be due to the convergence of the airline business models as argued by Ferrer-Rosella and Coender (2017). Since legacy carriers are engaging in cost-cutting tactics, they are slowly beginning to resemble low-cost carriers. Therefore, it would make sense that the effect of these pseudo-low-cost-carriers have the competitive effect closer to low-cost carriers than before.

In the pre-merger era, low-cost carriers have significant reduction in fares - the entry of the first low-cost carrier reduces fares by 14.6 percent. This makes economic theoretical sense, as low-cost carriers can have reduced cost structures and can therefore offer lower fares that attract consumers. In the post-merger era, the first entry of a first low-cost carrier is actually reduced to about 13.2 percent. However, entry from the additional low-cost carriers offering nonstop service is enhanced in the post-merger era due to the negativity of the coefficients. This may be because low-cost carriers expanded their market share (in terms of domestic passengers carried) over the years, and thus have more brand/name recognition. Brand/name recognition is important to airlines, as consumers are more likely to trust and fly with a brand they had flown with before or heard or (consider a consumer's general knowledge on Delta or Southwest Airlines, compared to their familiarity with Allegiant or Sun Country Airlines). This is perhaps evidenced by Brueckner et. al. (2013), where Southwest (arguably the most widely known low-cost carrier in the United States) has a larger reduction in fares compared to other low-cost airlines.

The impact of connecting fares are also interesting in the post-merger era. In the pre-merger era, competition from legacy connecting carriers actually increased incumbents' fares, whereas competition from low-cost connecting carriers reduced incumbents' fares by approximately three percent. This may indicate that although connecting service is largely more of a hassle, and thus lesser quality, low-cost carriers are still able to offer deeper discounts that consumers would be willing to fly connecting on a low-cost carrier than nonstop on any other carrier. In the post-merger era, however, competition from legacy carriers' connecting service turns negative, decreasing fares by approximately 4.6 percent. Conversely, competition from connecting low-cost carriers has a reduced effect, reducing incumbents' fares by less than one percent. Theoretically, this may be backed by the convergence of the low-cost carrier and full-service business models.

One notable coefficient is the estimation on the dummy variable that indicates which fares are in the post-merger era. The coefficient is 0.4485, which suggests that fares, on average, are almost 45 percent lower in 2016 - 2018 relative to the 2005 - 2007 time period. Whilst this seems surprising at first, there could be some explanation for this. First, perhaps the significant cost-cutting tactics and debundling of amenities engaged in by legacy carriers led to the fruition of lower fares (though this may also be reduced quality with the transfer of amenities from being part of the fare to being expensive add-on fees). Second, aircraft are increasing their fuel efficiency (such as the Airbus A320neo series and Boeing 737 MAX series, along with the few domestic flights that use the Boeing 787), thus reducing fuel costs.

Regression Diagnostics

The regression underwent a series of tests to generate statistics that will help determine how well the model fits the data. Other tests help determine whether or not econometric assumptions are met.

The fixed effects regression comes with three R^2 values, each of which determine which how well the results of the regression (the coefficients) explain the variation in the observed fares. A value of one means that the regression can explain one hundred percent of the variation in the fares. The overall- R^2 value is 0.5224, implying that the regression can explain

52.24 percent of the variation in all of the observed fares of the final data set. The within- R^2 value is relatively high, at 0.8452, suggesting that on average, 84.52 percent of the variation in observed fares within each city-pair market can be explained by the regression. Conversely, however, the between-R-squared value is 0.4366, implying that on average, the regression can explain 43.66 percent of the variation in fares between routes during the same time quarter. Although this R-Squared value does not satisfy a test, it is useful in determining how well the model predicts reality.

One of the first classical assumptions requires that there be no correlation between the independent variables (a condition referred to as multicollinearity). To diagnose this, a correlation matrix of the coefficients of the regression were used. Between the continuous variables, the absolute value of the highest correlation value is 0.1029, which was between passengers and the geometric mean of the income. This makes sense, as cities with higher incomes are likely to generate more passengers. However, this is a relatively small correlation. Between the dummy variables, there was relatively high correlation between the individual competition variables (for example: the normal *legacy_nonstop2* had a high correlation with the interaction of *post*legacy_nonstop2*). This is expected, however, as carriers do not change service frequently, especially if the route is profitable.

The distribution and expected values of the residuals is also important to note. Both the skewness and the kurtosis of the residuals are both equal to 0.0000, suggesting that the residuals of the regression are distributed normally. A normal distribution for the residuals allows for hypothesis testing. Additionally, the mean of the residuals is -0.00129. Arguably, this is relatively close to zero, and thus enough to satisfy the econometric assumption that the expected value of the residuals is zero.

Heteroskedasticity is the relationship between the residuals and the regressors. Heteroskedasticity was assumed, therefore another regression is run with robust standard errors. The results are seen in *Table 4* below. Most notably, many of the competition variables lost their statistical significance and were accompanied by an increase in their standard errors.

In testing for correlation, the above table should also be referred to. The robust standard errors in the fixed effects regression corrects the standard errors not only for heteroskedasticity, but also autocorrelation. Thus, we can assume that there is minimal autocorrelation and heteroskedasticity in the regression results under the robust standard error.

Finally, an F-Test was performed to see how well the general model is. The F-Test score is 0.0000 for both that non-robust and robust standard, suggesting that the model less than a 0.01 percent chance of a Type I Error. This implies that the model and the collection of variables used is statistically significant. It should be noted that this analysis meets several limitations. The first is that the data was restricted to include only round-trip fares, and therefore the estimated fare reductions cannot be applied to one-way tickets or multi-city itineraries. Additionally, since the DB1B database only contains data on domestic routes within the United States, this analysis cannot extend to international routes. Subsequently, the results are not applicable to how low-cost airlines outside the United States such as Ryanair and EasyJet affect competition due to the difference in airline-competition structure in Europe.

Table 4: Regression Estimates Under Robust Standard Error

Variable	Coefficient	Standard Error
Income (1000s)	0.0022085**	0.007411
Population (100,000s)	- 0.0018858	0.0017486
Distance (100s)	0.0015392	0.0011129
Passengers (100s)	- 0.0014013***	0.0002576
Legacy_nonstop2	- 0.003251	0.0077309
Legacy_nonstop3	- 0.0359914***	0.0102552
Legacy_connect1	0.0111292	0.0230676
LCC_nonstop1	- 0.1462011***	0.0107458
LCC_nonstop2	- 0.0399968**	0.0123103
LCC_nonstop3	- 0.0110259	0.0157679
LCC_connect1	- 0.0306448***	0.0084524
Post	- 0.4485369***	0.0290979
*Post*Legacy_nonstop2*	- 0.0334525*	0.0128098
*Post*Legacy_nonstop3*	- 0.029655	0.0200282
*Post*Legacy_connect1*	- 0.0571541**	0.0268102
*Post*LCC_nonstop1*	0.0145194	0.0106495
*Post*LCC_nonstop1*	- 0.0918607***	0.0155988
*Post*LCC_nonstop3*	- 0.0466627**	0.0193367
*Post*LCC_connect1*	0.0229644**	0.0095442
Intercept	6.034493***	0.0722969

Statistical Significance Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Conclusion

This paper examined how competition in the airline industry has changed since the pre-merger era. This research performed with the Passenger Origin and Destination Survey data investigated how different business models, different service types (nonstop or connecting), and different incremental entrances have different effects on incumbent's fares.

This paper finds that nonstop competition in the post-merger era is more competitive between legacy carriers and post-secondary low-cost carriers, but less so for the first low-cost carrier entering a market. Connecting competition from either has a relatively small impact on nonstop fares, though the overall effect in the post-merger era turns negative. Low-cost carriers still have a significantly larger impact on nonstop competition compared to legacy carriers, although the gap between the two impacts on incumbent fares is closing.

The timing of the COVID-19 outbreak and economic downturns associated with it may gain some insight from this paper's findings. The Great Recession caused a series of mergers between some of the largest airlines, and with one of the sharpest suspensions in air transport service ever seen in history, the airline industry may be due for another series of acquisitions. These findings may offer a glimpse of how competition will change over the next decade after the potential COVID-19 airline mergers.

Acknowledgements

This research paper was advised by Dr. Aziz Saglam, Senior Lecturer of Economics at the University of New Hampshire. Without his support and guidance, as well as his level-headed advice, this thesis could not have come to fruition. Furthermore, the research process and modeling were aided by Professor Reagan Baughman and Professor Andrew Houtenville, both of whom contributed greatly to econometric analyses and methods used here. I would like to thank everyone at the University of New Hampshire and London School of Economics who helped me develop my interest and passion for economics and airlines. Finally, thank you to my amazing friends and family who helped me succeed in life and support me in the writing of this honors thesis.

References

Alves, C., & Barbot, C. (2009). Price Discrimination Strategies of Low-cost Carriers. *Journal of Transport Economics and Policy*, *43*(3), 345-363. Retrieved April 3, 2020, from www.jstor.org/stable/40599974

Atallah, S., Hotle, S. L., & Mumbower, S. (2018). The evolution of low-cost Carrier operational strategies pre- and post-recession. *Journal of Air Transport Management*, *73*, 87–94. doi: 10.1016/j.jairtraman.2018.08.011

Azadian, F., & Vasigh, B. (2019). The blurring lines between full-service network carriers and low-cost carriers: A financial perspective on business model convergence. *Transport Policy*, *75*, 19–26. doi: 10.1016/j.tranpol.2018.12.012

BILOTKACH, V. (2017). COST. In *The Economics of Airlines* (pp. 17-26). Newcastle upon Tyne: Agenda Publishing. Retrieved April 3, 2020, from www.jstor.org/stable/j.ctv5cg8d9.7

Bureau of Transportation Statistics, 2016. Passenger travel facts and figures 2016. Retrieved from: https://www.bts.gov/archive/publications/passenger_travel_2016, Accessed date: 5 December 2017.

Brueckner, J. K., Lee, D., & Singer, E. S. (2013). Airline competition and domestic US airfares: A comprehensive reappraisal.

Economics of Transportation, *2*(1), 1–17. doi: 10.1016/j.ecotra.2012.06.001

Dresner, M., Lin, J., & Windle, R. (1996). The Impact of Low-Cost Carriers on Airport and Route Competition. *Journal of Transport Economics and Policy, 30*(3), 309-328. Retrieved April 3, 2020, from www.jstor.org/stable/20053709

Ferrer-Rosell, B., & Coenders, G. (2017). Airline type and tourist expenditure: Are full service and low cost carriers converging or diverging? *Journal of Air Transport Management*, *63*, 119–125. doi: 10.1016/j.jairtraman.2017.06.014

Kwoka, J., Hearle, K., & Alepin, P. (2016). From the Fringe to the Forefront: Low Cost Carriers and Airline Price Determination. *Review of Industrial Organization, 48*(3), 247-268. Retrieved April 1, 2020, from www.jstor.org/stable/44735137

Tan, K. (2016). Incumbent Response to Entry by Low-Cost Carriers in the U.S. Airline Industry. *Southern Economic Journal,82*(3), 874-892. Retrieved April 1, 2020, from www.jstor.org/stable/44283480

United States, Bureau of Economic Analysis (2018). “Personal Income by Country, Metro, and Other Areas”

United States, Census Bureau (2018). “Metropolitan and Micropolitan Statistical Area Tables.”

United States, Department of Transportation, and Bureau of Transportation Statistics. “Airline Passenger Origin and Destination Survey (DB1B Database).” *Airline Passenger Origin and Destination Survey (DB1B Database)*, Bureau of Transportation Statistics, 2020. https://www.transtats.bts.gov/DatabaseInfo.asp?DB_ID=125